FLOWMETERING: WHAT STRAIGHT PIPE REQUIREMENTS?

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During Rob’s work with flowmeters with SA Water in the late ‘80s and early ‘90s, he accumulated a lot of experience testing a range of flowmeters used for water supply and irrigation in closed flow. In this article he explores the straight pipe requirement for a range of flowmeters and looks at how a 10 diameter upstream/5 diameter downstream policy will affect real field flowmeter accuracy.

In a previous edition of Irrigation Australia journal (Summer 2009, Vol. 24, No. 04, pages 8 and 9), I described how the Propeller Actuated (P/A) flowmeter (see Illustration 1) needed at least twenty-five diameters of upstream pipework to restore its accuracy to within +/-5% when used downstream of the most common pipe obstruction, i.e. the 90° bend (see Graph 1).

The accuracy of these meters also diminishes with the area ratio of the propeller diameter to pipe diameter, i.e. as the propeller gets smaller, the accuracy diminishes. Metering accuracy is fully restored with only three diameters of straight pipe with the application of straightening vanes installed in the pipe-disruption and the meter (see Graph 2).

It could be argued that these meters are calibrated in the factory or NATA testing facilities with ten diameters of upstream straight pipe. The question then needs to be asked: “after what upstream pipe configuration?”

Unless this meter is installed in the field with that identical upstream pipe, disturbance, poor field accuracy will result. The fact is that most facilities calibrate flowmeters with pipe reducers upstream and not bends, plus lots of straight pipe before that, a situation rarely found in the field.

**Different flowmeters, different pipe requirements**

Turbine flowmeters are also axial flowmeters. If the turbine is less than a full bore, as are some irrigation meters, at least twenty-five diameters of straight upstream pipe will be required. Errors of 10 to 15%, usually slow, may result from only ten diameters of upstream straight pipe.

If the turbine is full bore and contains straightening vanes, as most turbine flowmeters do, then typically only three to five diameters of straight pipe upstream is needed. Of course, straightening vanes also trap weed and block the meter.

Hydrometers are turbine flowmeters with a hydraulic control valve built above its turbine (see photo). They have a vertical turbine with a flow conditioning chamber (high density straightening vanes) and do not require any straight pipe upstream. Manufacturers openly state this. The Meinecke “Cosmos WSD” Flowmeter used in water supply is also in this category. These flowmeters require clean water to stop the straightening vanes blocking.

The Multijet flowmeter is another category of flowmeter that has a built-in flow conditioner and therefore requires no straight upstream pipework. This meter is manufactured usually only up to 50 mm diameter.

The PA meter is an axial flowmeter, i.e. it has a sensor located centrally in the pipe. This type of flowmeter is calibrated to operate at the centre of a symmetrical velocity profile and, until that is achieved, the propeller will usually be subject to a lower velocity component of the velocity profile.

Hydrometers have conditioning chambers with straightening vanes and require no straight pipe upstream. Photo: ARAD.

**In summary**

In summary, what all this means is that typical straight pipe requirements for measuring downstream of a 90° bend would be:

- PA meter 25 diameters
- Turbine, no vanes 25 diameters
- Turbine, with vanes 3 diameters
- Hydrometer 0 diameters
- Multijet 15 diameters
- Paddlewheel 15 to 25 diameters

My next article will examine ultrasonic and magnetic flow meters accuracy.

**About the author**

Rob Welke is a pumping and hydraulics consultant based on the Gold Coast. For more information on flow metering, go to www.talle.biz/metering.html or contact Rob at rob@talle.biz.